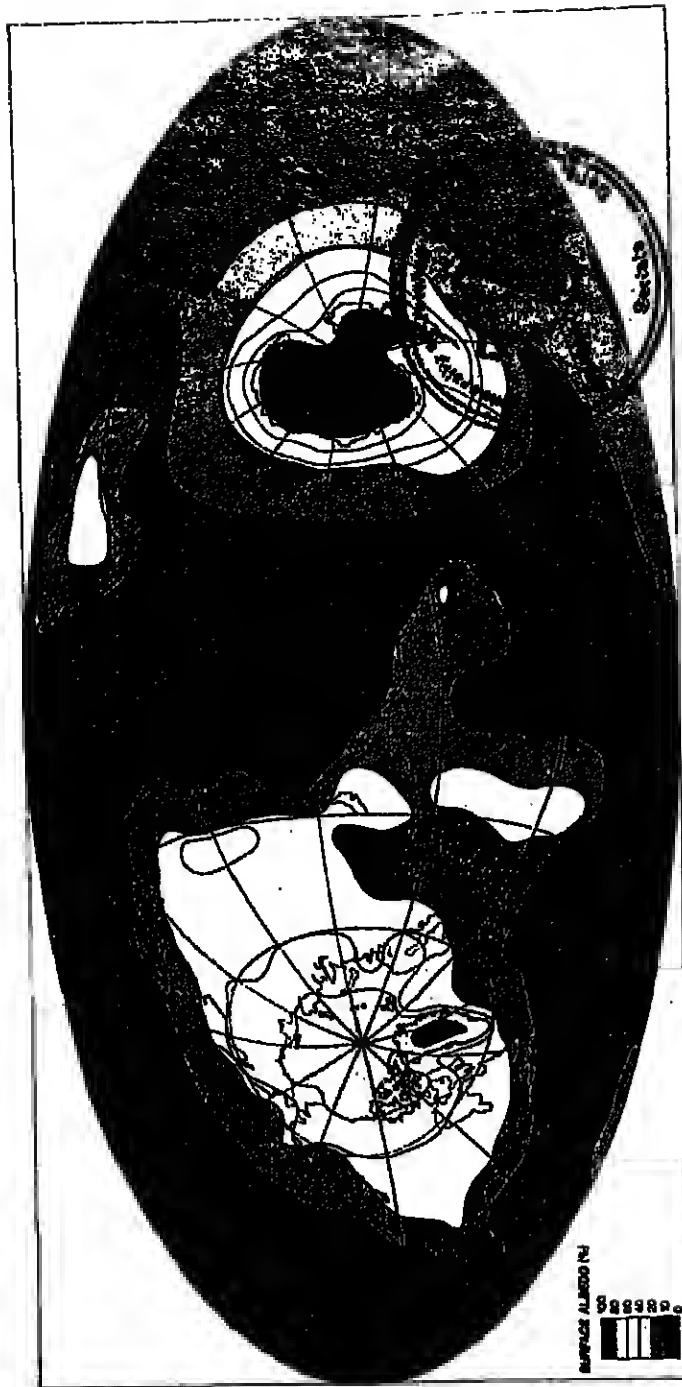


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Donde Va? An Oceanographic Experiment in the Alboran Sea

The Donde Va Group

Introduction

During June-October 1982 an international consortium of oceanographers studied the circulation of the western Alboran Sea in an experiment entitled "Donde Va?" Although the English translation of this title is "Where does it go?", our goals were more ambitious than the name implies. In this overview of Donde Va? we will discuss the oceanographic background of the region, the objective of the experiment, and the preliminary results.

Oceanographic Background

The Alboran Sea is the westernmost of the many basins that comprise the Mediterranean Sea. A narrow (10-30 km) current of Atlantic water (fresher than 36.5 salinity) flows eastward through the Strait of Gibraltar with a volume transport of about 1.4×10^6 m³/s, while saline Mediterranean water (38.4 salinity) flows westward beneath it with a transport

that is about 45% less. This two-layer flow maintains the salt and water balance of the Mediterranean which annually loses about 1 m over its surface through the excess of evaporation over river runoff and precipitation (Lacombe, 1984). While intuition might lead one to anticipate that the Atlantic water entering the Mediterranean would be found along the Moroccan coast (i.e., turning to the right upon exiting the strait), in fact the inflow is found near Spain, where it forms the northern half of a basin-wide anticyclonic gyre (Lanoux, 1974; Cheney and Doblar, 1982; Parrilla and Kinder, 1984). There have been several model studies of the gyre (Whitehead and Miller, 1979; Nof, 1978; Preller and Hurlburt, 1982), and it is nearly always detectable in satellite infrared images (Phillips and Harang, 1982).

Objectives

The primary objective of the experiment was to understand the dynamics and the variability of the anticyclonic gyre by using numerical modeling, remote sensing, and field measurements. Our hypothesis was that the Atlantic inflow is the primary forcing mechanism for the gyre, so that if we made synoptic measurements of the inflow and of the gyre, and compared these measurements to numerical model simulations, then we could increase our understanding of the gyre dynamics.

The experiment addressed numerous secondary questions including:

1. What is the structure of the Intermediate and Deep Water flows, and how do these flows contribute to the Mediterranean outflow?
2. What is the biological and chemical influence on the gyre's strong ocean color signal, and how is this signal related to the physical structure of the gyre?
3. How does the strong front along the northern limb of the gyre affect the atmospheric marine boundary layer, and how does the marine boundary layer then affect remote sensing data?
4. How are the surface signatures of the gyre, as measured by satellite and aircraft sensors, related to the subsurface structure of the gyre?
5. How does atmospheric forcing influence the gyre, both directly and through changes in the Atlantic inflow?

The experiment had three overlapping phases, all ending in late October 1982. The first phase began in October 1981 and consisted of satellite monitoring (about 2 processed images per month) of the thermal surface features. The second phase began in June 1982, when five current meter moorings were deployed, a small hydrographic grid was occupied, and satellite image processing began.

During the final phase in October 1982, four ships occupied stations in the Alboran Sea, the Strait of Gibraltar, and the Gulf of Cadiz (the area of the Atlantic Ocean just west of the strait); four aircraft performed remote sensing and AXBT flights; a shore-based current measuring radar (CODAR) operated; additional meteorological and aerosol data were collected; and all available NOAA 7 (advanced very high resolution radiometer, AVHRR) and NIMBUS 7 (coastal zone color scanner, CZCS) images were obtained. The meeting report on an October 1983 workshop contains a detailed account of the experiment and some early results (Parrilla, 1984). We will briefly discuss the preliminary results of the intensive October 1982 phase.

Preliminary Results

The experiment had three overlapping phases, all ending in late October 1982. The first phase began in October 1981 and consisted of satellite monitoring (about 2 processed images per month) of the thermal surface features. The second phase began in June 1982, when five current meter moorings were deployed, a small hydrographic grid was occupied, and satellite image processing began.

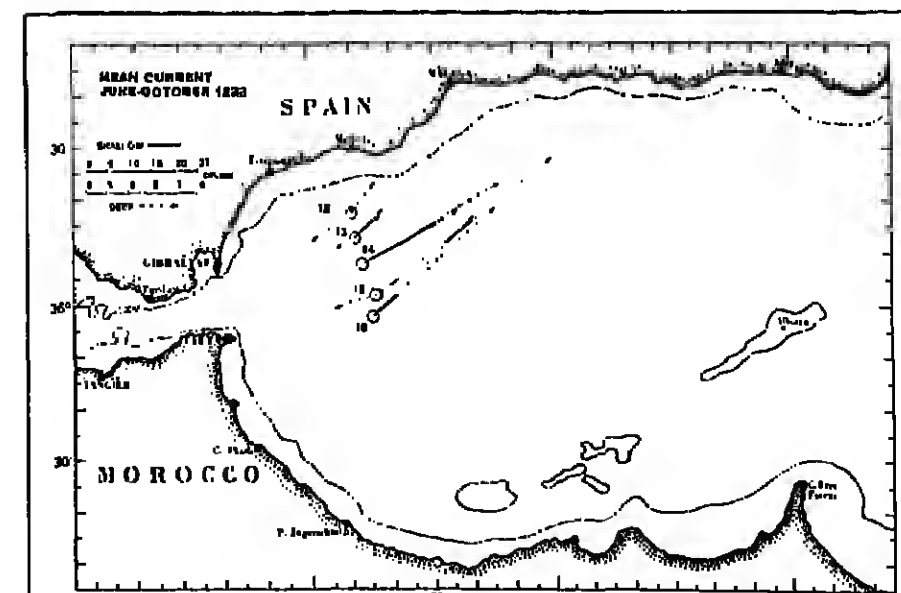


Fig. 1. Salinity at 100 dbar, showing the structure of the Atlantic inflow and gyre at depth.

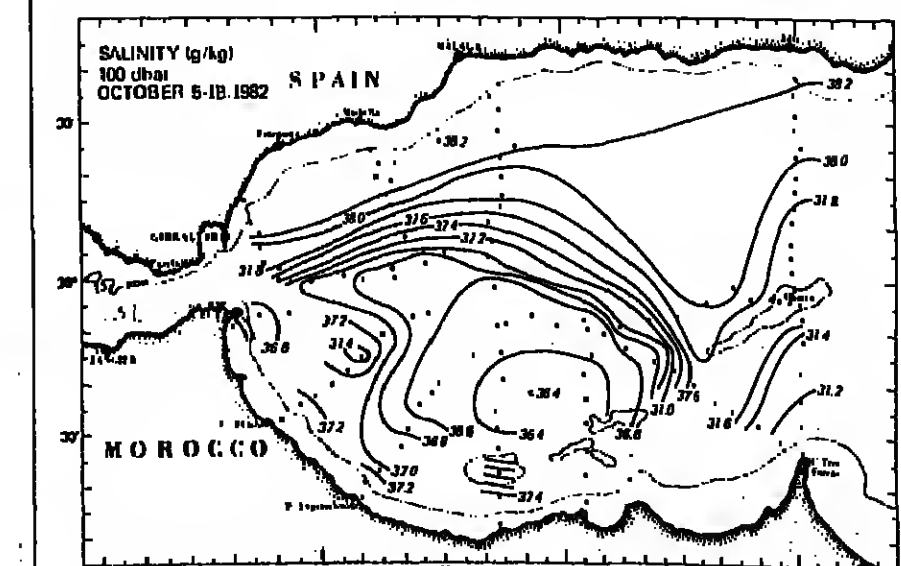


Fig. 2. Mean velocities from the current meters. The solid arrows are from instruments in the Atlantic inflow at the gyre, while the dashed arrows (note scale change) were in the lower part of the Mediterranean Intermediate Water.

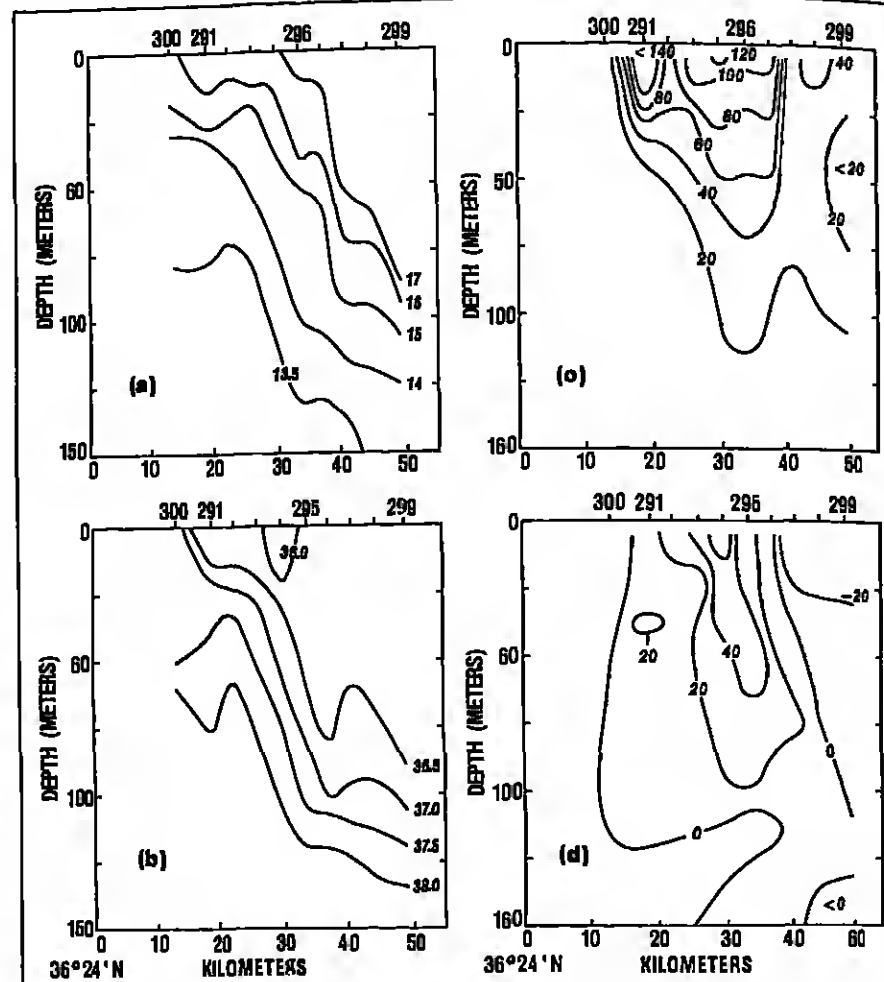


Fig. 3. CTD current profiles measured south of Estepuna during October 16-17. The currents were measured and not inferred from the hydrography; (a) temperature (°C); (b) salinity; (c) eastward velocity (cm/s); (d) northward velocity (cm/s). The bottom axis is distance south of 36°24'N, and the top axis station location.

sisted of satellite monitoring (about 2 processed images per month) of the thermal surface features. The second phase began in June 1982, when five current meter moorings were deployed, a small hydrographic grid was occupied, and satellite image processing began. During the final phase in October 1982, four ships occupied stations in the Alboran Sea, the Strait of Gibraltar, and the Gulf of Cadiz (the area of the Atlantic Ocean just west of the strait); four aircraft performed remote sensing and AXBT flights; a shore-based current measuring radar (CODAR) operated; additional meteorological and aerosol data were collected; and all available NOAA 7 (advanced very high resolution radiometer, AVHRR) and NIMBUS 7 (coastal zone color scanner, CZCS) images were obtained. The meeting report on an October 1983 workshop contains a detailed account of the experiment and some early results (Parrilla, 1984). We will briefly discuss the preliminary results of the intensive October 1982 phase.

Optical, Biological, and Chemical Measurements

Simultaneous measurements of visible and infrared radiation from both aircraft (multispectral scanner and ocean color radiometer) and satellite (CZCS and AVHRR) sensors clearly pictured the gyre and the Atlantic inflow (Figure 4). The CZCS images were geometrically registered to a Mercator projection and atmospherically corrected for quantifying chlorophyll concentration and for the diffuse attenuation coefficient. These results and the aircraft data indicated that high chlorophyll concentrations were correlated with cool sea surface temperatures. Surface thermal fronts were coincident with ocean color fronts on the large scale, although differences appeared at smaller scales. Results of the CZCS showed surprisingly large daily changes in chlorophyll concentration and attenuation coefficient across the entire sea. Along the northern front formed by the gyre and the Atlantic inflow, chlorophyll changed from 1.05 to 0.45 mg/m³ and the attenuation coefficient from 0.15 to 0.07 within 24 hours. The cause of these changes is still under scrutiny. If the cause is either biological or physical, then the rapidity, areal extent and size of the changes will be a significant new result.

In situ optical and biological measurements were concentrated along the mooring line (Figure 2). These measurements showed large temporal and spatial changes in the optical and thermal structure. Correlation with satellite images and other data showed that much of the temporal change was associated with variations in the structure of the Atlantic inflow and gyre. Biological and nutrient concentrations also had a complicated and variable structure. Phosphate concentrations were higher (0.3-0.7 μg at P-PO₄) than was previously found, and some high nitrate concentrations also suggested that upwelling or mixing may have been supplying nutrients to the photic zone. High chlorophyll concentrations were associated with the high nitrate. Diatoms were strongly dominant, with *Rhizosolenia* *Stohlerii* the most abundant.

Current measurements also showed high speeds with strong variability in the gyre and the inflow. Five short-period (4-5 hour) surface measurements of sonobuoy drift tracks showed that the core of the inflow was associated with a cool sea surface temperature and speeds of 120 cm/s. South of the inflow, the speeds in the gyre averaged 80 cm/s, although some higher speeds were measured. Surface currents measured by radar (CODAR) over a region extending 60 km south of Marbella (depending on interference and propagation conditions) were well correlated with geostrophic estimates and current meter data. CODAR measurements showed that the center of the inflow current had a width of 15-30 km, that it moved more than 30 km farther offshore in 4 days, and that it had multiple velocity maxima of 8-18 km width.

Submesoscale Thermal Features
Examination of the twice-daily infrared images (see cover) and visible CZCS images (Fig.

[Janopaul and Frisch, 1984]. During October, the current meters (Figure 2) showed the subsurface velocity core shifting between mooring 14 and 15, with the highest speeds at the shallowest meters (depths of 67-124 m) exceeding 80 cm/s. The best-resolved velocity section, taken with the CTD velocity profiler south of Estepuna, revealed a current of about 25 km width, 100 m depth (20 cm/s), and surface speeds of 120-140 cm/s (Figure 3). This section also showed that in the highest horizontal shear regions of the current, large along-section velocities made the nonlinear terms in the momentum equations nearly as large as the Coriolis term. Generally, the geostrophic estimates appear valid, but details on scales of 10 km or less in the high shear regions may be inaccurate.

ure 4) revealed tongues of colder and more turbid water that were pointed toward the center of the gyre. They appeared first near the strait and then apparently were advected around the gyre at a mean speed of 40 cm/s [La Violette, 1984]. These features had a horizontal dimension of 10-20 km (compared to the internal deformation radius of 15-30 km) and a vertical extent, measured by AXBT sections, of at least 100 m. Salinity from a CTD cast obtained within one feature was in

the range of Atlantic water. During 15 days of cloud-free satellite images, nine features could be tracked most of the way around the gyre. Because they appeared to originate near the strait about twice per day (the same frequency as the NOAA satellite passes), we conjecture that the strong Strait of Gibraltar tides may influence their formation.

Meteorology and Aerosols

Shore stations and shipboard measurements, including soundings and aerosols, provided dense observation of the lower atmosphere. These data were obtained to check the influence of the atmosphere on the gyre (Cheney and Doblar, 1982; Buca and Kinder, 1984) and on remote sensing measurements. The marine boundary layer was modified by cooling and warming due to the air-sea temperature differences over the water masses on either side of the sea surface thermal fronts. The boundary layer over the colder water was 50 m lower than over the warmer gyre water, had a stable inversion layer overlying a shallow surface layer, and had a greater concentration of smaller-sized aerosols. Aerosol populations over the Alboran Sea (gathered by ship) were characterized by large diurnal variations in concentration, size, and chemical composition. On the average, sub-micron sized particle concentrations were approximately 50% greater over the colder water (probably trapped in the low level inversion), while concentrations of particles > 1 micron were comparable in both areas. Wave data inferred from aircraft photography also showed smaller wave heights in the colder water. The correlations of these atmospheric parameters with oceanographic features can both complicate interpretation of remote sensing images and offer clues to useful analysis.

Internal Waves

Nonlinear internal waves (often described as bores) have been known in the Strait of Gibraltar for decades. For the first time, however, our data show that these eastward-propagating waves often form ordered groups of short period (about 30 min) waves in the Alboran Sea, apparently as internal solitons [Osborne and Burch, 1980]. These waves have sufficient amplitude (exceeding 50 cm/s in eastward velocity) to affect measurement programs and perhaps directly influence larger scale dynamics as well. The waves were common, forming during most semidiurnal tidal cycles but with varying strength.

Gulf of Cadiz

Hydrographic observations in the Gulf of Cadiz showed Atlantic water near the Spanish coast flowing toward the strait. The Mediterranean outflow appeared to move down five submarine canyons along the Iberian slope, mixing with the surrounding waters. There were several gyres or eddies in the dynamic topographies, including an anticyclonic gyre (near 36°20'N and 7°10'W) that has been detected in CZCS images. Velocity profiling south of Cape St. Vincent (extreme southwestern Portugal) indicated that the Mediterranean water was moving at speeds of less than 10 cm/s. In these data and companion CTD data, the temperature and salinity at the core of the Mediterranean water fluctuated as much as 1°C and 0.2 over either distances of a few kilometers or periods of a few days (spatial and temporal fluctuations on these scales could not be separated because of ship movement).

Numerical Modeling

Reduced gravity models (single active layer above a quiescent lower layer) used by Preller and Hurlburt [1982] demonstrated the importance of both the magnitude and direction of the inflowing Atlantic water in the determination of the gyre dimensions. Inflow directed north of east, and thus conforming to the orientation of the Strait of Gibraltar, enlarged the north-south extent of the gyre. Increasing the magnitude of the inflow intensified the gyre and shifted it farther east.

When a westward-flowing lower layer was included, the importance of the bottom topography became apparent. In cases of large inflows ($> 1.7 \times 10^6$ m³/s) with an initial northward component, the submarine ridge system near Alboran Island deflected the flow northward. This deflection eliminated the anticyclonic gyre west of the island. Smaller inflows, such as the 1.4×10^6 m³/s estimated for October, resulted in a large anticyclonic gyre west of the island (Figure 5).

Deep and Intermediate Water

Hydrographic sections showed that the Deep and the Intermediate Water took separate paths through the Alboran Sea. The Deep Water flowed as a narrow (20 km) current against the base of the Moroccan continental slope and then appeared at the eastern end of the strait along the southern side, much as predicted by Bryden and Stommel [1982]. The Intermediate Water, however, appeared to flow preferentially in the northern two thirds of the Alboran Sea, arriving at the eastern end of the strait along the northern side. The Deep Water flow was thus anticyclonic, like the shallow Atlantic water gyre, while the Intermediate Water flow was cy-

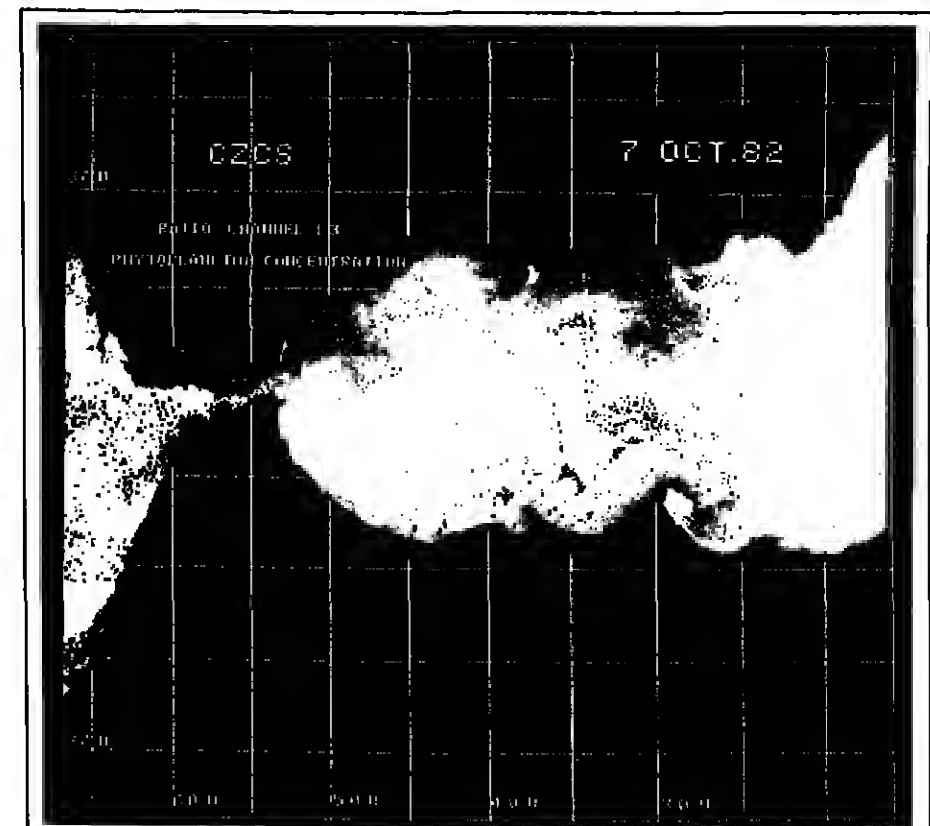


Fig. 4. CZCS image on October 7, 1982. Darker shades correspond to higher phytoplankton pigment concentrations (cf. cover).

clonic. Two-layer numerical model experiments suggested that this pattern resulted from the influence of rotation on the Intermediate Water and of bathymetry on the Deep Water.

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Oceanography (cont. on p. 684)

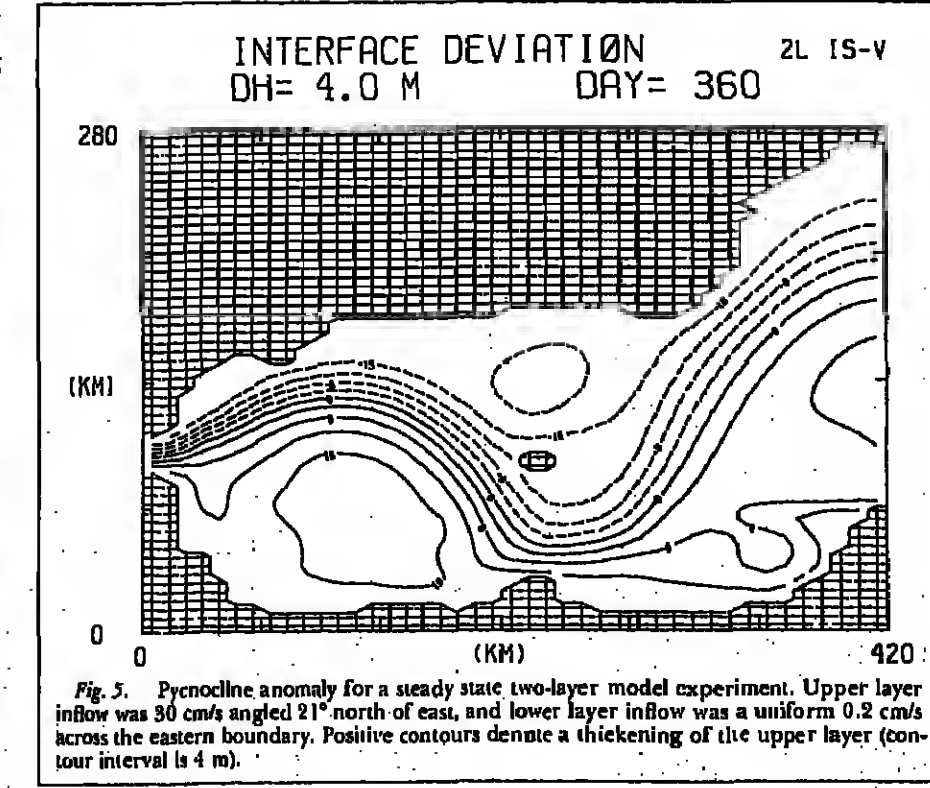


Fig. 5. Pycnocline anomaly for a steady state two-layer model experiment. Upper layer inflow was 30 cm/s angled 21° north of east, and lower layer inflow was a uniform 0.2 cm/s across the eastern boundary. Positive contours denote a thickening of the upper layer (contour interval is 4 m).

Oceanography (cont. from p. 683)

A Global Ocean Flux Study

John H. Steele

A major goal for oceanography in the next decade is an understanding of ocean dynamics at basin and global spatial scales and at time scales from the interannual through the decadal. This understanding is not only of intrinsic interest and importance for the oceans themselves but is an essential component of the larger problems concerning the cycles of heat, water, and chemical constituents through the land, air, and sea. To the extent that the oceans act as the "flywheel" for the total system at these longer time scales, our level of understanding of this component is likely to be critical.

The larger concerns are expressed in general national and international programs, such as the "global habitability" concept of the International Geosphere-Biosphere Program (IGBP, February 21, 1984). The essential foundation for such biogeochemical concepts is a knowledge of the physical dynamics. The Global Atmospheric Research Program (GARP), and, more recently, the World Climate Research Program and its oceanographic components, Tropical Ocean Global Atmosphere (TOGA) and the proposed World Ocean Circulation Experiment (WOCE), are aimed at providing the necessary knowledge of the zero-order (steady state) and first-order variability of the ocean-atmosphere system.

The critical next step is to consider how we may link these physical studies to an emerging understanding of chemical fluxes within and through the ocean, particularly as they determine and are determined by long-term biological cycles and trends. The basic distribution of critical chemical constituents is observed in two major programs, GEOSERCS and TTO (Transient Tracers in the Ocean). Follow-up programs are expected to continue through the next 5 years. To link these observations in the physical dynamics and to the biological processes, measurements are needed of fluxes of soluble and particulate phases and of the rates of transformation between these phases.

In the last few years there has been considerable and rapid development of methods for the measurement of these rates. The use of sediment traps has revolutionized our picture of particulate transport rates in the deep ocean. A reevaluation of near surface production is in progress. Satellite color observations provide the potential for large-scale synoptic data. Deployments of benthic chambers at the deep ocean bottom can now measure fluxes through this boundary. Exchanges across the coastal/ocean boundary are being studied intensively, as are questions of lateral transports to the ocean interior. It is recognized that there is need for further development of these methods, but, taken together, they provide for the first time the possibility to put numbers to many, if not all, of the critical rate processes.

Can these new techniques, combined with the programs of physical and chemical obser-

vations, provide a picture of the basic long-term chemical/biological dynamics at the basin or global space scales? Can we envisage a coherent program of development and deployment over the next 5-10 years? Do we have the conceptual basis, possibly expressed through numerical modeling, to explore the size and nature of such a program?

It is timely to consider these questions in the context of developments within the fields of chemical and biological oceanography and also in relation to the programs for study of the physical dynamics. There need to be close links between such programs, but the methods for, and interests in the nonconservative tracers requires an independent approach.

Preliminary discussions have identified several key topics where concepts and technologies need to be evaluated: (1) sediment traps and large volume sampling methods; (2) production cycles and satellite observations; (3) exchanges across the benthic boundary, including shelf/ocean transports; (4) modeling simulations as planning tools; and (5) relation with existing physical and chemical programs (WOCE, TTO).

A meeting of experts in these areas was called by the Board on Ocean Science and Policy of the National Research Council to consider the feasibility of developing a program that would provide a coherent framework for joint studies and which could lead to a major field effort in the next 5-10 years. This meeting was held on February 14-16, 1984, in Washington, D.C.

The meeting discussed the topics and techniques listed above. The group also discussed fully the relation between a "flux" program and existing or proposed programs such as TTO and WOCE. In particular, it was recognized that theoretical and numerical modeling studies could be used to link the physical dynamics with the chemical and biological processes. Work is required on the models that may be most appropriate for this purpose.

From a general review of the present range of programs such as those measuring tracers (e.g., TTO), the varied studies using sediment traps (e.g., Sediment Trap Intercomparison Experiment and Vertical Transport and Exchange Experiment), and benthic flux work (e.g., Mangrove Nodule Program), one major conclusion emerged. We need to study not only vertical but also horizontal transport of major "particle-reactive" components on space scales of basin or global dimension and on time scales from the interannual through decadal. Thus any coherent program must aim to view these interactions at the larger scales.

A second major conclusion was that, although existing analytical and sampling techniques have the potential to provide answers on the appropriate scales, there is a significant prior need to test the capability of some techniques for larger scale use and, especially, to have a better understanding of the processes, physical, chemical, and biological, which drive the system at certain critical locations. Thus, a larger coherent program is envisioned for a time frame probably starting no earlier than 1990, but planning for this must be closely linked to a plan of intermediate objectives and field programs.

The following scientific objectives were proposed: (1) to define the rate of production of organic matter as a function of geo-

graphic location and time; (2) to define the flux rates of organic matter from the photic zone into the ocean interior as a function of location and time; (3) to define the transfer rates (by respiration, dissolution, and sorption) between phases as a function of time and location within the water column; and (4) to define the rate of flux between the ocean interior and the seafloor. It was agreed that certain immediate steps were needed as a building toward a fully developed program.

1. *Remote Sensing:* Satellite color images would provide essential data to cover the range of space and time scales envisaged for ocean basin or global studies. Recent reports demonstrate the ability to use these data for estimates of primary production. Thus, the group strongly supported the proposed OGI (Ocean Color Imager) and the need to have it introduced into the next budget cycle so that the satellite may be in orbit for a time period overlapping the altimeter and scatterometer flights (approximately 1990-1995).

At the same time, the group realized the need to demonstrate the specific uses for OGI data in the larger-scale context (the major achievements using color data have been for mesoscale studies). Thus, a thorough study is required of existing data to determine the statistics of (1) data availability by geographic location and season (the problem of cloud cover at the basin scale); (2) data variability as a function of location and space and time scales; and (3) the mean values for use in productivity calculations.

2. *New and Recycled Production in the Photic Zone:* There is a significant discrepancy between direct (short-term, "bottle") measurements of primary production in the photic zones and indirect (long-term field data) estimates derived from combining chemical and physical measurements. The differences (involving factors of 2-5) may be due in part to semantics (what is "production," what is "new" and "recycled"); or to great differences in space and time scales (bottle versus $\delta^{13}C$); but there is still sufficient divergence that must be eliminated or resolved before this component of a global flux study has a sound basis.

3. *Integrated Process Studies:* The development of sediment trap technology has led to an outburst of activity in different regions and in relation to a wide range of problems from near surface fallout to lithogenic transports. The diversity of use demonstrates the versatility of this technique, and these uses should continue. At the same time, for studies of the overall cycles in larger ocean regions, we need some integration of trap techniques, of sample analyses and of other methods (e.g., production; benthic chambers) to be used in close conjunction with trap deployments.

Given the consensus of a capability to carry out a major program on ocean fluxes, combined with the need to prepare for this by several immediate actions, the group proposed the following goals.

1. To determine whether we have the potential to obtain ocean data on a global scale that could profoundly change our understanding of the flux of critical chemical constituents.
2. To identify the immediate and long-term objectives needed to achieve the Global Ocean Flux Program.
3. If the ability is achievable, to determine

the U.S. role in such an international program.

4. To specify the immediate steps necessary to assure that an appropriate program can be conducted within the next decade.

To meet these goals, the group proposed there should be a 5-day workshop with 40 participants, which is tentatively scheduled to be held in Woods Hole during September 1984. It is to be chaired by Ken Bruland. Any questions or comments should be addressed to Dr. Kenneth W. Bruland, Associate Professor, Division of Natural Sciences, Applied Science Building, University of California, Santa Cruz, Santa Cruz, CA 95064.

This article was written by John H. Steele, *Contributor, February 14-16, 1984, Workshop. He is with the Woods Hole Oceanographic Institution, Woods Hole, MA 02543.*

Meetings

NATO Advanced Study Institute

The NATO Advanced Study Institute (ASI) will present lectures on modern numerical methods and physical parameterization for ocean circulation modeling for developing physical understanding. The models will encompass a broad range of subjects, including storm surge, mixed layer, eddy-resolving, quasi-geostrophic, primitive equation, and climate models.

The ASI will be held in Banyuls-sur-mer, France, from June 2-15, 1985. The director is James J. O'Brien, The Florida State University, Tallahassee, FL 32306. The French organizer and coordinator is Michel Crepon, Lab. d'Océanographie Physique, Muséum National d'Histoire Naturelle, Paris, France. Principal lecturers are Alan Davies, U.K.; François Ronday, Belgium; Bert Semtner, United States; Mark Cane, United States; David Anderson, U.K.; and Lars Petter Rodhe, Norway. Several other lecturers will be selected in the near future. Bernard Saint-Guilhem is the local host.

Forty-five students from NATO countries will be chosen to attend the ASI. These people should be advanced graduate students, recent Ph.D.'s, and research assistants with an interest in earth physical oceanographic numerical modeling. Persons who wish to attend as a student should send a curriculum vitae and one or two references from professors in their country to Dr. O'Brien or Dr. Crepon by November 1, 1984.

All interested scientists are encouraged to apply to be a lecturer at the ASI. However, space is limited. A letter indicating the content of your lectures should be sent to Dr. O'Brien by October 1, 1984. From the applications, invitations will be issued to speakers. Lecturers are expected to attend for a minimum of 1 week.

Limited travel money is available from NATO to support participants. Additional travel money is being sought from NATO member countries. All applicants should indicate their requirements for travel funds. French participants should contact Dr. Crepon, Paris. All other participants should contact Dr. O'Brien.

Senior Level Hydrogeologist. *Requirements:* M.S. + 5 years experience as Project Manager. Computer modeling and writing skills imperative. Strong background in applied hydrogeology integrated with chemistry and engineering desirable. *Remuneration:* Commensurate with experience plus excellent benefits and growth potential. *Response:* In confidence submit resume, references and salary history to Mrs. V.L. Borso, R.E. Wright Associates, Inc., 3240 Schoolhouse Road, Middletown, PA 17057.

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including description of research interests, list of publications, resume of teaching experience, and names of at least three references for Chairman, Graduate Department, A-408, Scripps Institution of Oceanography, University of California, San Diego, La Jolla, CA 92093. Closing date for applications is 15 October 1985. We expect to fill the position in calendar year 1986.

An Equal Opportunity/Affirmative Action Employer. Women and minorities are especially invited to apply.

These must be submitted by November 15, 1984 to:

Martin Prinz
Chairman, Search Committee
Department of Mineral Sciences
American Museum of Natural History
New York, NY 10024

An equal opportunity [M/F/H] affirmative action employer.

Scripta Institution of Oceanography/Marine Geophysics. The Scripta Institution of Oceanography invites applications for a tenure track position in solid-earth geophysics/geochemistry. The level of the appointment will depend on the applicant's qualifications. Candidates will be expected to supervise and conduct research in geophysical studies or geophysics with emphasis on the ocean basins and their margins. The position will also involve graduate level teaching and the supervision of graduate student research. Applicants must hold Ph.D. degree and have demonstrated excellence and independence in research in geophysical-geochemical studies. Assistant level candidates will be expected to show evidence of their potential through publication history. This is a research position, but some time is needed for collections management

Leadership and self-starting qualities, strong client contact capabilities, excellent writing and communication skills will help qualify for this challenging position. Excellent benefits and salary commensurate with experience in a dynamic technical environment. Send resume and salary history to: 1151 Duryea Ave., Irvine, CA 92714.

DIRECTOR
HYDROGEOLOGY DIVISION
Leighton and Associates, Inc., a rapidly growing Geotechnical Consulting Firm based in Southern California, has an opening for a Director to head its Hydrogeology Division. An MS degree in Hydrogeology from a major university and minimum 10 years industry experience, or a Ph.D. with a minimum 5 years industry experience or equivalent level of academic experience with publications is required. Responsibilities include:

- Development of innovative solutions to ground-water problems;
- Preparation of successful proposals for major regional projects;
- Management of field-oriented ground-water evaluation programs;
- Supervision of ground-water modeling efforts;
- Evaluation of hazardous waste contamination and cleanup procedures.

Applicants should submit a curriculum vitae, a list of publications, and Office of Personnel and Management Standard Form 171 (Personal Qualifications Statement) to Dr. Franklin D. Martin, Director of Space and Earth Sciences, Code 600, NASA/Goddard Space Flight Center, Greenbelt, Maryland 20771. Selection will be made by the Director of Goddard Space Flight Center, with the aid of a search committee of recognized experts in appropriate disciplines. Deadline for applications is October 15, 1984.

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DIRECTOR OF HAZARDOUS WASTE MANAGEMENT AND TWO SENIOR HYDROGEOLOGISTS

SHANNON & WILSON, INC., a leading national geotechnical and applied geoscience consulting firm with 30 years of experience, has immediate openings for a Director of Hazardous Waste Management and a senior-level Hydrogeologist in its St. Louis office and a senior-level Hydrogeologist in its Seattle office. The successful candidate will lead the company's existing well established groundwater and hazardous waste groups. Each position will require proven business development and project management skills and national-class technical expertise.

The Director of Hazardous Waste Management will provide overall leadership of the company's Waste Management work. The successful candidate must have an advanced degree in a related field and over 15 years of direct experience in site characterization, groundwater-quality assessment, and remedial action methods.

The senior-level Hydrogeologists must have an advanced degree in geology or hydrogeology and over 10 years of direct experience in water resource development, geotechnical projects, groundwater modeling and groundwater contamination studies.

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Attn: Earl A. Sibley
P.O. Box C-30313
Seattle, WA 98103-8067

An Equal Opportunity Employer

Chairman/Division of Meteorology and Physical Oceanography. The Rosenfeld School of Marine and Atmospheric Science, University of Miami, is searching for a Chairman of its Division of Meteorology and Physical Oceanography. The Division consists of 16 faculty, 28 scientific and technical staff and 25 graduate students.

Applicants should be well established scientists in Meteorology or Physical Oceanography. Preference would be for a sea going Physical Oceanographer. Applications, including a current professional resume and names of three references, should be sent by 15 October 1984 to Dr. Friedrich Schott, Chairman Search Committee, Rosenfeld School of Marine and Atmospheric Science, 4600 Rickenbacker Causeway, Miami FL 33149.

Position will remain open until filled. The University of Miami is an equal opportunity/affirmative action employer.

Princeton University. The Department of Geological and Geophysical Sciences invites applications for a tenure track appointment beginning September 1, 1985, at the Assistant Professor level in the area of Isotope Geology with specialization in $^{40}Ar/^{39}Ar$ mass spectrometry.

Candidates must be thoroughly grounded in the fundamentals of isotope studies (stable and radiogenic) and their application in earth science, and have demonstrated an ability for research in this related field. The appointee will be expected to supervise our newly assembled continuous-laser-based Argon gas laboratory, and to participate in collaborative research programs using this facility.

Teaching duties are to complement and expand the existing program.

Applicants should send resume and names of three references to Robert A. Phinney, Chairman, Department of Geological and Geophysical Sciences, Princeton University, Princeton, N.J. 08544. Princeton University is an equal opportunity/affirmative action employer.

Hydrogeologist/Texas A&M University. The Department of Geology and Center for Engineering Geosciences have a tenure track opening, preferably assistant professor level, for which the first search will be for a creative individual working in applied hydrogeology.

The successful applicant will be expected to develop teaching and research recognition at a national level. The position is available beginning September 1, 1984 and will be held open until filled. Applicants should submit a vita including names of references to M.C. Gilbert, Department of Geology, Texas A&M University, College Station, TX 77843.

Texas A&M University is an affirmative action/equal opportunity employer.

NASA/Goddard Space Flight Center

Associate Chief Space Data & Computing Division & Head National Space Science Data Center

NASA/Goddard Space Flight Center is seeking a highly qualified individual to head the National Space Science Data Center (NSSDC). The position is for Associate Chief of the Space Data and Computing Division within the Space and Earth Sciences Directorate. The NSSDC is the principal scientific data center for NASA and operates World Data Center A for rockets and satellites. This center serves as the permanent scientific space data archive and dissemination center and is responsible for the development, management, and operation of specialized data base systems for NASA. Particular disciplinary emphasis is in solar-terrestrial physics and astrophysics. The center develops advanced data base management systems using leading technologies such as high speed mass storage retrieval systems, data base machines and expert systems. The staff consists of approximately 30 civil servants and 100 contractor personnel. The NSSDC operates an expanding computing system currently consisting of a VAX 11/780 and a MODCOMP IV/25 and will have high-speed link to an IBM 3081, a Cyber 205, and a cluster of VAX processors. NSSDC responds to world-wide requests for documentation, data services, and digital and photographic data. As Associate Chief, the incumbent will also participate in formulating the research policy and long-term direction of the Division. The position calls for both technical and managerial leadership of the organization. The appointee must be at the GS-15 level, which carries a salary range of \$30,495-\$65,642.

Qualifications: Goddard is seeking a respected and visionary scientist willing to play a strong leadership role at a challenging time. Applicants should possess a Ph.D. or the equivalent experience in one of the following: a space or earth science-related discipline; computer science, or mathematics. Experience of at least 10 years, with increasing responsibility and stature, including management of a substantive technical group. Applicant should have been closely involved with advanced research utilizing scientific satellite data including data management and analysis and experienced in modern computer systems, technology, and telecommunications. In addition, applicant should have a broad understanding of the science areas in which NSSDC is involved.

Applicants: Applicants should submit a curriculum vitae, a list of publications, and Office of Personnel and Management Standard Form 171 (Personal Qualifications Statement) to Dr. Franklin D. Martin, Director of Space and Earth Sciences, Code 600, NASA/Goddard Space Flight Center, Greenbelt, Maryland 20771. Selection will be made by the Director of Goddard Space Flight Center, with the aid of a search committee of recognized experts in appropriate disciplines. Deadline for applications is October 15, 1984.

NASA is an affirmative action/equal opportunity employer.

Seismologist/Department of Geology/University of Illinois at Urbana-Champaign. Applications are invited for a tenure track position at the Assistant Professor level in the field of seismic imaging. The position is expected to be filled by fall 1985. Salary is commensurate with experience; an earned Ph.D. is required. A creative individual is needed who will develop a research program that can complement our existing programs in geophysics, conformational seismology, geotechnics, and rock-mechanics physics. Specialists from subfields including reflection/refraction seismology, exploration seismology, marine or continental seismic profiling, and seismic tomography are encouraged to apply. An excellent research environment and outstanding facilities are available both in the Department of Geology and the University. Opportunity exists to interact with the Illinois State Geological Survey on campus. The successful candidate is expected to participate in all aspects of teaching and advising at the graduate and undergraduate levels. For equal consideration, interested individuals should send curriculum vitae, list of publications, statements of research interest and names of three or more references by December 15, 1984 to: Professor Albert T. Hsu, Department of Geology, University of Illinois at Urbana-Champaign, 1301 W. Green Street, Urbana, Illinois 61801. Telephone: 217-333-7732 or 333-3542. University of Illinois is an equal opportunity/affirmative action employer.

University of Texas at Austin. The Department of Geological Sciences seeks to fill tenure track positions effective fall 1985 in one or more of the following disciplines: 1) microplate tectonics; 2) hydrogeology; and 3) mineralogy-geochemistry. Each person is expected to teach both undergraduate and graduate courses and to conduct a vigorous research program, including the supervision of graduate students, in the area of his or her specialty. The positions require the Ph.D. degree. Applicants should submit a detailed resume, names and addresses of five references, a statement of teaching and research interests, and a copy of their dissertation abstract by December 1, 1984 to: Dr. William L. Fisher, Department of Geological Sciences, The University of Texas at Austin, Austin, Texas 78713-7002.

The University is an equal opportunity/affirmative action employer.

Stanford University/Plasma Physics, EM Waves, Space Physics. We are seeking a senior person who has demonstrated scientific, managerial, and leadership qualifications in one or more of the following disciplines: Space Plasma Physics, electron waves, and/or solar wind physics. We expect the successful candidate to have established an outstanding reputation (demonstrable through professional writings or other evidence of personal technical creativity, letters of reference, recognized research leaders in the disciplines mentioned) above, author awards and other recognition from appropriate professional societies.

It is expected that this individual will develop a research program in one of the disciplines given above working in conjunction with ongoing programs within the STARC Laboratory and, possibly, with other activities within the Stanford Center for Space Science and Astrophysics. It is expected that this individual will have a strong background in experimental techniques, either in the laboratory or in the field, including the environment of space exploration. The position is either a tenure track or a senior plasma physicist would be regarded as good qualifications. However, close association with theoretical developments in plasma physics and/or electromagnetic theory will greatly be desired. It is also desired that the individual will have a demonstrated capability for securing federal or other research grant support, or be deemed by the selection committee of being capable of securing such funds.

It is anticipated that the person chosen will devote the major part of his or her time to research activities. However, there is an opportunity for participation in academic responsibilities of Electrical Engineering Department, including, when time permits, teaching graduate and undergraduate classes, serving on various committees of the department, School of Engineering, and the University. It is expected that the person chosen will participate actively in the training of graduate students.

The Chairman of the selection committee for this position is Professor Robert A. Helliwell, Professor of Electrical Engineering, Space, Telecommunications, and Radioscience Laboratory, Stanford University, Stanford, CA 94305. Other members of the selection committee include Professor F.M. Banks, Professor R.N. Bracewell, Professor L.R.O. Storey, and Professor L. Tyler.

Project Associate/Specialist: Electro Micro-Probe Lab, University of Wisconsin-Madison. Strong analytical background in quantitative EMP analysis and familiarity with computers is required. The Lab has a 9-spectrometer ARL SEMQ and a JEOLCO 50A SEM. Duties will include instrument maintenance, instruction of students, development of protocols and analysis. Research will be encouraged. A MS or PhD is required in Earth Science, Chemistry, Physics or Engineering. Minimum salary will be \$18,000/12 months with an M.S. Send letter of application, curriculum vitae, and names and addresses of three references by September 15 to Dr. John W. Valley, Department of Geology & Geophysics, Weeks Hall, University of Wisconsin, Madison, WI 53706.

An equal opportunity employer.

Satellite Geodesy. The scientific staff position available 1 October 1984 at the Massachusetts Institute of Technology, Department of Earth, Atmospheric, and Planetary Sciences, is a federally appointed long-term program research geodesy position in the Department of Earth, Atmospheric, and Planetary Sciences. Candidates must have Ph.D. in geodesy, and ability and experience in radio interferometry with satellites, as demonstrated by publications and references. Expertise in FORTRAN scientific programming, in statistics, in the theory of satellite geodesy, and in parameter estimation techniques applicable to large, multiparameter geodesic problems is essential. Experience in performing field work and in data processing on large IBM mainframe and/or small PDP-11 computer systems would be helpful, as would knowledge of GPS, geoid reference systems, and network adjustments. Strong skills in oral and written presentation of research results are required.

Please send vita, including list of publications, letter of interest, and references, plus reprints of major publications to: Professor Charles C. Counselman, III, 60 L.M. Bixhette, Room 19E, Cambridge, MA 02139.

MIT is an affirmative action/equal opportunity employer.

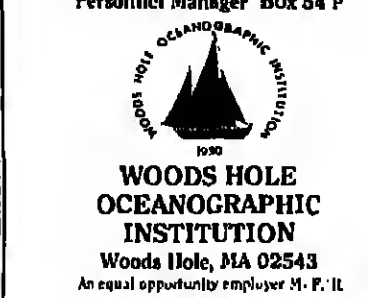
Geophysics/University of North Carolina. The Department of Geology invites applications for a tenure track faculty position in solid-earth geophysics beginning July 1, 1985. The position holder will be at the assistant professor level, but candidates at the associate professor level will be considered.

RESEARCH POSITIONS IN MARINE GEOLOGY AND GEOPHYSICS

Woods Hole Oceanographic Institution invites applications from researchers active in the fields of marine geology and geophysics to fill available positions on the scientific staff of the Department of Geology and Geophysics. We seek applicants at a broad range of experience levels, from immediately post-doctoral to those with 10 or more years of research experience. Salary levels negotiable, depending primarily on background and experience.

The Institution offers excellent facilities to carry out the full spectrum of practical and theoretical marine earth science research. A strong interest by candidates in conducting programs of marine G&C data acquisition and analysis is preferred; a capability to conceive, fund and carry out independent research programs is required. In addition to Geology and Geophysics, the Institution consists of 4 well-established research departments specializing in the fields of Biology, Chemistry, Physical Oceanography and Ocean Engineering. Collaborative research with members of the staff of these departments is strongly encouraged. Opportunities also exist for participation in the Joint Massachusetts Institute of Technology-Woods Hole Oceanographic Institution graduate level education program.

Applicants should send resumes and names of 3 professional references to: Personnel Manager Box 54 P



rest. The Ph.D. is required, and professional experience is desired. Our preference is for a sedimentologist and/or tectonophysics, who would complement current departmental activities, but any good applicant in geophysics will be considered. Faculty members are expected to conduct a visible and active research program, teach graduate and undergraduate students, and supervise these.

Qualities and letters of application should be sent to P. Geoffrey Feiss, Department of Geology, 029A, University of North Carolina, Chapel Hill, NC 27514. Applications must include resume, statement of research and teaching interests, and the names of at least three references. Closing date for applications is October 19, 1984.

URG is an affirmative action/equal opportunity employer.

Physical Oceanographer/Ocean Engineer. Evans-Hamilton Inc., an oceanographic consulting firm in Washington, D.C. area, has an opening for a physical oceanographer/ocean engineer at the MS or PhD level. Emphasis is in numerical modeling of wind, wave, tide, and currents in estuary and on the shelf and also on solving related coastal engineering problems. Some experience in data acquisition and/or analysis is desirable. Salary is open. Company provides medical and profit sharing plans. Send resume to: Douglas J. Evans-Hamilton, Inc., 354 Hungerford Drive, Rockville, MD 20850 or call 301-782-8070.

Soil Scientist Career Federal Service. The Agricultural Research Service U.S. Salinity Laboratory, in Riverside, California, has a position available for a scientist interested in conducting theoretical research on the transport, storage and dissolved substances through soils. Research should result in a set of models that describe the behavior of salts and water in soil systems. Must have knowledge of advanced soil physics, soil chemistry, and soil-water relations. Salary based on qualifications and experience. GS-11/12/13, \$25,485/\$36,327. Applications must be U.S. citizens. For application procedures call Rita Millard in Beltsville, Maryland, on 301-344-3138.

An equal opportunity employer.

Cooperative Institute for Climate Studies/Announcement of Postdoctoral Fellowship. The Department of Meteorology at the University of Maryland, College Park has established the Cooperative Institute for Climate Studies (CICS) with NOAA to engage in collaborative research. The Institute is involved in a variety of studies oriented toward a better understanding of climate and currently has an opening for a postdoctoral fellow to join the current Institute staff in the area of steady state climate modeling. This position calls for a meteorologist with experience or interest in experiments with steady state climate models. Principal activities will involve running experiments with existing steady state models, deriving careful verification procedures, handling extensive observed data sets, making modifications in model physics and forcing, and making more efficient computational schemes for running the models.

Letters of application should be sent to: F. Baer, Director, CICS, Department of Meteorology, University of Maryland, College Park, MD 20742. Applications should include a curriculum vitae and names of three references. Applications received before October 15, 1984 will receive full consideration.

The University of Maryland subscribes to a policy of equal educational and employment opportunity. The University of Maryland, under Title IX of the Education Amendments of 1972, does not discriminate on the basis of sex in admission, treatment of students or employment.

Classified

RATES PER LINE
Portions Available, Services, Supplies, Courses, and Announcements: first insertion \$3.00, additional insertions \$1.25.
Positions Wanted: first insertion \$2.00, additional insertions \$1.50.
Student Opportunities: first insertion free, additional insertions \$2.00.

There are no discounts or commissions on classified ads. Any type of fee that is not published, is charged at general advertising rates. Ads are published weekly on Tuesday. Ads must be received in writing by Monday, 1 week prior to the date of publication.

Replies to ads with box numbers should be addressed to Box _____, American Geophysical Union, 2000 Minnie Avenue, N.W., Washington, DC 20009.

For more information, call 202-462-6903 or toll free 800-424-2488.

POSITIONS AVAILABLE

Department Head of Plant Sciences/University of Nevada Reno. The College of Agriculture, University of Nevada Reno, is seeking applications for a twelve-month tenure track position. The Department has nineteen faculty and conducts teaching, research and extension programs in the areas of agronomy, horticulture and integrated pest management. A Ph.D. in a plant science related discipline and evidence of administrative and leadership abilities are required. Closing date for applications is October 15, 1984. The position is available January 1985. Contact Dr. Howard Miller, Chairman, College of Agriculture, UNR, Reno, NV 95957-0003, 702-784-6811.

The University of Nevada Reno is an equal opportunity employer.

American Museum of Natural History. The Department of Mineral Sciences is seeking to fill a tenure track position for a Assistant Curator beginning July 1985. This is a research position, but some time is needed for collections management

RESEARCH PHYSICIST, ASTROPHYSICIST, OR GEOPHYSICIST

The Spectroscopy Section of the Solar Physics Branch, Space Science Division is engaged in ultraviolet solar research by means of ground-based observations, sounding rockets, and manned and unmanned satellites.

We invite applications for the position of Project Scientist for a major satellite experiment which will fly on the Upper Atmospheric Research Satellite. The selected will conduct investigations to develop the technical tools necessary to study the variability of the Sun in the ultraviolet spectrum. He/she will be a co-investigator of the NRL-UMRS experiment. In this capacity the selected will conduct his/her own research in the area of solar variability and/or upper earth atmospheric physics.

Qualifications required: A bachelor's or higher degree in physics and at least three years of professional experience which involved performing basic and/or applied research in the fields of optics, spectroscopy, solar physics, or geophysics.

Interested applicants should submit a Personal Qualifications Statement (SF-171) or detailed resume by 28 September 1984 to:

GM-12/14
\$66,527 TO
\$85,807
PER ANNUM
(Salary dependent
upon qualifications)

SPECTROSCOPY
SECTION
SOLAR PHYSICS
BRANCH
SPACE SCIENCE
DIVISION



NAVAL
RESEARCH
LABORATORY
Civilian Personnel Division
Attn: 41-58-13 (EOS)
4555 Overlook
Avenue, SW
Washington, D.C. 20375

An Equal
Opportunity Employer
U.S. Citizenship Required

Faculty Position/University of Missouri-Columbia

The University of Missouri-Columbia invites applications for a tenure position in the Department of Geology. The position is in the field of sedimentary geology and is expected to be made at the Assistant Professor level, but exceptional candidates might be considered at higher rank. Faculty members are required to provide quality instruction at both undergraduate and graduate levels, and conduct research leading to scholarly publications. The following fields will be reviewed: sedimentary geology, stratigraphy, sedimentation, sedimentary geochemistry, or tectonics. Duties will include teaching courses in stratigraphy, sedimentation, sedimentary geochemistry, or tectonics.

Hydrogeology - preference will be given to a person with a strong mathematical/theoretical background in modeling of fluid flow, and with the capability and interest in pursuing this research in water resources.

Sediment geophysics (to complement two sedimentologists joining our staff in January 1985) - preference will be given to a person with research interest in heat flow, potential fields, or geophysical modeling.

Applicants should send resume, transcripts, and names and addresses of three references to:

Tom Freeman, Chairman
Department of Geology
University of Missouri
Columbia, MO 65211

Harvard University/Faculty Position in Petrology

The Department of Geological Sciences, Harvard University, invites applications for a faculty position in petrology. We are interested in persons concerned with the mineralogy and the major and/or trace element chemistry of metamorphic and igneous rocks in relation to their geologic and tectonic setting. Experience with modern methods for the study of natural rocks, both in laboratory and in the field, is essential. The successful applicant must have the Ph.D. degree and demonstrated capabilities to conduct original research and to teach both undergraduate and graduate students. The appointment will be made at the Assistant or Associate Professor level depending on qualifications and experience. The 1984-85 salary ranges are \$28,600-\$33,800 for Assistant Professor and \$31,800-\$35,800 for Associate Professor. Appointments are made for an initial term of up to five years. Interested applicants should send vita, bibliography, and names of three references to:

Professor Adam M. Dzikowski
Harvard University
Hoffman Laboratory
20 Oxford Street
Cambridge, MA 02138

Harvard University is an equal opportunity/affirmative action employer. Women and minorities are encouraged to apply.

Faculty Positions/University of Colorado, Denver

The Physics Department of the University of Colorado at Denver is recruiting for several tenure track faculty positions in the Fall Semester of 1985. We are especially interested in applicants for appointments at the level of Assistant Professor; however, we will also consider senior appointments for appropriately qualified applicants. The teaching assignment is anticipated to be a total of three courses per academic year, including involvement in the undergraduate laboratory program. A record of scholarly publications in refereed journals will be required for advancement.

A successful candidate will be expected to provide high quality teaching over a broad range of undergraduate physics courses to students who are highly motivated and, because of our urban environment, somewhat older than the average college student. In addition, our department is developing a research program to support graduate instruction primarily at the M.A. and M.S. degree level. We are looking for physicists with research competence in one of the following areas: geophysics, environmental science, applied solar energy, or nonlinear phenomena. Applicants should be willing to play a role in the development of a strong physics department supportive of related disciplines such as geology, engineering, chemistry, and mathematics.

If you would like to apply to join our faculty, please send to us a letter of application, a current resume, and three letters of recommendation. Applications must be postmarked before 15 October, 1984. Please send them to the responsible person having the letters of recommendation sent to us. Please send applications or inquiries to:

William Chappell
Department of Physics
Division of Natural and Physical Sciences
1100 Foothill Street
Denver, Colorado 80202

The University of Colorado is an equal opportunity/affirmative action employer.

The University of Kansas/Faculty Positions. The Department of Geology seeks to fill three tenure track positions at the Assistant Professor level to begin in Fall, 1985. The Department seeks persons committed to academic careers involving teaching, research, and service. Salaries will be determined by qualifications and experience and will be competitive. Candidates should hold the

Ph.D. degree in Geological Sciences or have it near completion.

All positions carry responsibility for teaching at both undergraduate and graduate level, conducting active programs of research and publication, and supervising the research of students. Candidates should expect to teach introductory courses as well as in their specialties. The Department may give preference to those who are qualified physically and by training or experience to teach in our summer field programs and have the capability to use the computer to solve geological problems.

Position 1. Sedimentation, with interests in the interface between sedimentary processes and stratigraphy, diagenesis and low-temperature geochemistry, or tectonics. Duties will include teaching courses in stratigraphy, sedimentation, sedimentary geochemistry, or tectonics.

Position 2. Petrology, with interest in the interface between tectonic processes and sedimentation, igneous phenomena, or metamorphism. Duties will include teaching courses in structural geology and tectonics or petrology. Candidates with field orientation will be preferred.

Position 3. Geophysics, with interests in seismology, crustal structure, or potential fields. Candidates should expect to interact with a strong group in the Kansas State Geological Survey and coordinate the academic aspects of the program in geophysics. Duties will include teaching courses in geophysics, crustal structure, or tectonics.

Applicants should send a resume, academic transcripts, and at least three letters of recommendation to: M.E. Bickford, Chairman of Search Committee, Department of Geology, University of Kansas, Lawrence, Kansas 66045-2124. Application materials must be received by 5:00 p.m. November 18, 1984. The positions are contingent upon availability of funds.

The University of Kansas is an AA/EEO employer and encourages applications from all qualified persons.

Department of Geology and Geophysics/University of California, Berkeley. Subject to final budgetary approval, the Department is authorized to make two faculty appointments, one at the senior level and one at the junior level, and anticipates making two further appointments next year. Applicants with an outstanding record of research in any field of geology and geophysics are encouraged to apply. The ability to carry out leading research, as well as an interest in teaching graduate and undergraduate students, are major factors in the selection. Applications, including the names of at least three references, should be sent by December 15, 1984 to the Search Committee, Department of Geology and Geophysics, University of California, Berkeley, California 94720.

The University of California is an equal opportunity/affirmative action employer.

Postdoctoral Research Position/Petrology-Geochemistry Northern Illinois University. Department of Geology. Recent Ph.D. recipient is sought for one year position starting in early 1985. Strong analytical background in XRF or plasma spectrometry is preferred. The Department of Geology is in the process of acquiring new, automated XRF and DC plasma spectrometers. The successful candidate will be involved in the development of sample-preparation, analytical, and data-reduction procedures as well as instruction of other users. Independent or collaborative research will be expected. The Department also has solid- and gas-source mass spectrometers, automated EMP, and excellent computing facilities. Please send application, resume, and the names of three references to: J.H. Berg, Department of Geology, Northern Illinois University, DeKalb, IL 60115. Application deadline is October 15, 1984.

Northern Illinois University is an affirmative action/equal opportunity employer.

Academic Administrator/Assistant or Associate Research Oceanographer. The Center for Coastal Studies, Scripps Institution of Oceanography has an opening for a full-time position. 50% Academic Administrator/50% Assistant/Associate Research Oceanographer.

The Center conducts a wide variety of field, laboratory and theoretical work in waves, currents, shore processes, mechanics of nearshore sediment transport, estuarine processes, continental shelf and marginal seas research.

The successful candidate will have a Ph.D. in physical oceanography or coastal sciences. The level of appointment will be determined by experience and level of independence in higher level research as evidenced by reviewed publication record in the scientific literature and research record. The ability and desire for interaction with a variety of people within and outside the University particularly with other agencies, are essential. Knowledge of a broad spectrum of research areas is also essential. Some understanding of administrative issues, e.g., personnel and budget, is essential.

The Administrator portion of the position is permanently state-funded. The Research portion will be funded by the Center for 18-18 months to complete the candidate's later alumnus grant/fellowship funding either separately or in cooperation with other department research.

able the candidate to later alumnus grant/fellowship funding either separately or in cooperation with other department research. Good issues, including areas of research interest and list of publications, with three letters of reference by 31 October 1984 to: Or. Douglas L. Timman, Director Center for Coastal Studies, A-000 Scripps Institution of Oceanography University of California-San Diego La Jolla, CA 92093 UCSD is an Equal Opportunity/Affirmative Action Employer.

Monash University, Victoria, Australia. Department of Earth Sciences Geophysics and Petrology. 18 Year Lectureship/Research Fellowships in Geophysics. Commencing early 1985. One position for a scientist with research expertise in any of: theoretical seismology, solid Earth geophysics, tectonophysics, geodynamics, or exploration geophysics and one position for a scientist with demonstrated research ability in exploration seismology. Possible extension of fixed-term position to 3 years. Applicants to establish research programmes involving industry and government support, develop an undergraduate and graduate program covering applied and theoretical geophysics, and supervise Master's and Ph.D. students. Applicants with expertise in thermomechanical modelling will find an environment with strong interest in mechanisms of deformation, fluid/rock interaction including mass transport and thermal modelling, and physical volcanology. Equities to: Dr. Ian A. Nicholls, Senior Lecturer-\$A\$35,840-\$A\$32,634 p.a., Senior Lecturer-\$A\$33,351-\$A\$38,847 p.a. Curriculum vitae including description of research and teaching interests, and three references to the Registrar, Monash University, Clayton, Vic. 3168 Australia, by 1st October 1984. An Equal Opportunity/Affirmative Action Employer.

University of Wisconsin-Milwaukee/Faculty Position in Atmospheric Sciences. The Atmospheric Sciences Division in the Department of Geological and Geophysical Sciences will have a tenure track/junior position supported by State funds at the Assistant Professor/Associate Professor level starting January, 1985. Starting salary will depend upon the candidate's experience and will be competitive with other universities. Applicants must have a Ph.D. in meteorology or atmospheric sciences and have interest to pursue a career in teaching and research. We are seeking an individual with research interests in one or more of the following specialties: microclimate, mesoscale meteorology and modeling; synoptic dynamics; or climate dynamics and modeling. The successful applicant will be expected to develop a strong research and graduate program in his or her area of expertise and to teach two courses 15 or more credit hours per semester at the undergraduate and graduate level.

Research opportunities at UWM include satellite meteorology, severe storm dynamics and energetics, diagnostic modeling, large-scale circulation and energetics, synoptic meteorology and numerical modeling. Research facilities include MCIDAS, Great Lakes Research Facility, Urban Research Center, and a rural field station. Interested candidates should forward their resumes to: Professor N.P. Lucas, Chair, Department of Geological and Geophysical Sciences, University of Wisconsin-Milwaukee, P.O. Box 413, Milwaukee, Wisconsin 53201, with transcripts and the names of three persons well acquainted with the applicant's background and research potential. Closing date is October 31, 1984. UWM is an affirmative action/equal opportunity employer.

College of Geosciences/University of Oklahoma. Applications and nominations are invited for the position of Director of the School of Geology and Geophysics. The Director is expected to have a Ph.D. or equivalent, a strong ongoing research program and administrative experience; industrial experience helpful; field of geological specialization open to all disciplines. The successful candidate will be expected to establish a vigorous research program involving graduate students. The person who fills this position will join an active program in structural geophysics, tectonics or geophysics. It is anticipated that this position will be filled as the assistant professor level, but applications by more senior persons will be considered if the applicant's background and research potential. Closing date is October 31, 1984. UWM is an affirmative action/equal opportunity employer.

University of Utah/Structural Geology/Tectonics/Tectonophysics. The Department of Geology and Geophysics at the University of Utah seeks applications for a tenure track position in structural geology, tectonics or tectonophysics. It is anticipated that this position will be filled as the assistant professor level, but applications by more senior persons will be considered if the applicant's background and research potential. Closing date is October 31, 1984. UWM is an affirmative action/equal opportunity employer.

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Marine Research Specialist IV/V. Two positions. Develop programs related to processing and display of data from Sea Beam Sonar System. Operate and maintain complex electronic systems onboard ships, up to three months sea time per year. Supervise shipboard and shore based operations. Maintain hardware and software. Develop software for digital acquisition of Sonar and Navigation data. Analyze marine navigation, bathymetric and acoustic data through use of advanced signal processing, image processing, interactive graphics and map making techniques. Master's degree or equivalent in Computer Science, Physical Science or Engineering or equivalent experience. Proven programming ability in FORTRAN and ASSEMBLY languages, and VAX/VMS operating systems required. A working knowledge of computer electronics as well as experience at sea is strongly preferred. Submit resume and references to: Dr. Robert C. Tyce, Marine Research Specialist IV/V Position, THE UNIVERSITY OF RHODE ISLAND, P.O. Box 557, Kingston, RI, 02881-0557.

An AA/EEO employer.

William M. Rice University/Marine Geophysics. The Department of Geology invites nominations and applications for the W. Maurice Ewing Chair in Oceanography. We are seeking an individual for a new position in marine geophysics with full chair.

The Department of Geology has recently added two reflection seismologists to its faculty and is building a state-of-the-art seismic research facility. The successful applicant will be expected to teach graduate and undergraduate courses and to develop a strong research program in his or her area of interest. Cooperation in ongoing research with other members of the Rice faculty and faculty at other Texas universities would be encouraged.

Send inquiries and applications to: Dr. Albert Bally, Chairman, Department of Geology, Rice University, Houston, Texas 77251-1699. Applications should include a detailed resume, the names and addresses of three references, and a statement of research interest.

Rice University is an equal opportunity/affirmative action employer.

Research Geophysicist. The U.S. Geological Survey (USGS), Office of Earthquakes, Volcanoes, and Engineering, Branch of Seismology is seeking an individual for an exceptionally well-qualified person with either a record of demonstrated ability or outstanding potential for research in one or more areas of the branch activity. The branch of Seismology conducts fundamental research in the fields of earthquake

EARTH SCIENCES

The Lamont-Doherty Geological Observatory of Columbia University invites recent Ph.D. recipients or candidates for their degree in 1985 in any field of the earth sciences to apply for postdoctoral fellowships awarded for a period of one year (extendable to two years, in special instances) beginning in September 1985 with a stipend of \$26,000 per annum.

Completed applications are to be returned by January 15, 1985. Application forms may be obtained by writing to the Director, Lamont-Doherty Geological Observatory, Palisades, New York 10964. Award announcements will be made on or about February 28, 1985.

Columbia University is an affirmative action/equal opportunity employer.

prediction, network seismology, crustal structure and volcano seismology. The branch is particularly interested in a geophysicist with expertise in the field of seismology.

All interested persons should submit a detailed resume of education, experience, summary of interests and research intentions, and the appropriate salary commensurate with experience by 5 October 1984 to:

William Ellsworth
U.S. Geological Survey
Branch of Seismology
3415 Middlefield Road, MS-977
Menlo Park, CA 94025

Should a position become available in the Branch, you will be notified of the competitive Federal employment application requirements.

The U.S. Geological Survey is an Affirmative Action/Equal Opportunity Employer.

University of Utah/Structural Geology/Tectonics/Tectonophysics. The Department of Geology and Geophysics at the University of Utah seeks applications for a tenure track position in structural geology, tectonics or tectonophysics. It is anticipated that this position will be filled as the assistant professor level, but applications by more senior persons will be considered if the applicant's background and research potential. Closing date is October 31, 1984. UWM is an affirmative action/equal opportunity employer.

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POSITIONS WANTED

Teaching and/or Research - Geology, Paleontology, Geophysics, Mining and Petroleum Engineering. Extensive practical and teaching experience in the US and abroad. Specialist in resource evaluation and development - multilingual working Persian and Turkish. Salary and rank negotiable. Reply to Box 026, American Geophysical Union, 2000 Florida Avenue, N.W., Washington, D.C. 20009.

STUDENT OPPORTUNITIES

Predoctoral Research Assistantship In Geochemistry. Individuals are invited to apply for a research

Meetings

Announcements

Earth Science Editors Meet

Oct. 8-10, 1984 18th Annual Association of Earth Science Editors Conference, Portland, Oregon. Association of Earth Science Editors, 4220 King St., Alexandria, VA 22302.

Topics to be discussed include concerns of the working editor in editing and preparing manuscripts and illustrations (including the use and development of style guides, in-house training programs, understanding how illustrations communicate, changes in methods of making maps, and compatibility of electronic tools); managing journals and improving the journal publication process; interfacing between publishers and printers; getting reviewers to do their job; applying microcomputers to journal management; abstracting and indexing services; their needs and value; strategic planning; writing and improving newsletters; reporting scientific hazards (including the roles of scientists, editors, information specialists, and journalists); and the responsibilities of those issuing and reporting hazards information.

Water on Mars

Nov. 30-Dec. 1, 1984 NASA/Lunar and Planetary Institute Workshop on Water on Mars (part of Mars: The Evolution of its Climate and Atmosphere), Moffett Field, Calif.

AGU

AGU Membership Applications

Applications for membership have been received from the following individuals. The letter after the name denotes the proposed primary